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Patented Free-Space Optical System for Auto Aligned Optical Beam Allowing to Compensate Mechanical Misalignments

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Abstract : In optical systems such as Variable Optical Delay Lines, where a collimated beam has to go back and forth, corner cubes are used in order to keep the reflected beam parallel to the incoming beam. However, the reflected beam can be laterally shifted, which will lead to losses. In this paper, we report on a patented optical design that allows keeping the reflected beam with the exact same position and direction whatever the displacement of the corner cube leading to zero losses. After explaining how the optical design works and theoretically allows to compensate for any defects in the translation of the corner cube, we will present the results of experimental comparisons between a standard layout (i.e., only corner cubes) and our optical layout. To compare both optical layouts, we used a fiber-to-fiber coupling setup. It consists of a couple of lights from one fiber to the other, thanks to two lenses. The ensemble [fiber+lense] is fixed and called a collimator so that the light is coupled from one collimator to another. Each collimator was precisely made in order to have a precise working distance. In the experiment, we measured and compared the Insertion Losses (IL) variations between both collimators with the distance between them (i.e., natural Gaussian beam coupling losses) and between both collimators in the different optical layouts tested, with the same optical length propagation. We will show that the IL variations of our setup are less than 0.05dB with respect to the IL variations of collimators alone.

Keywords : free-space optics, variable optical delay lines, optical cavity, auto-alignment
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